Is the decline in UK road accidents since 2012 consistent across geography, severity, and demographics?

Composite Visualization

Figure 1

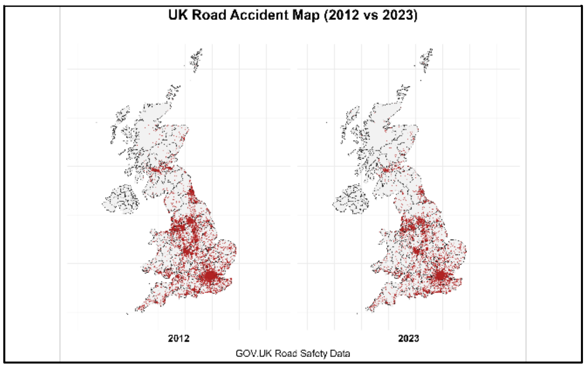


Figure 2

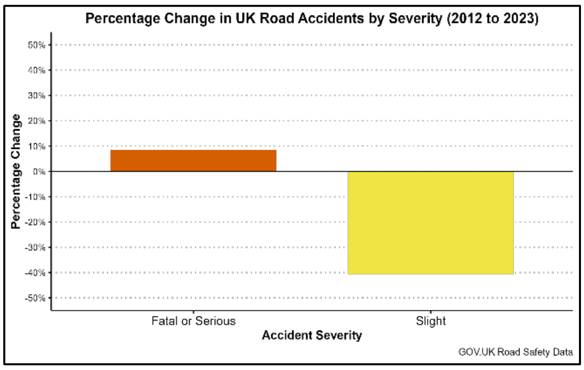


Figure 3

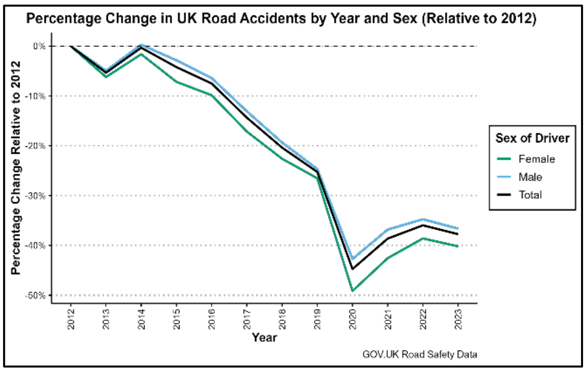


Figure 4

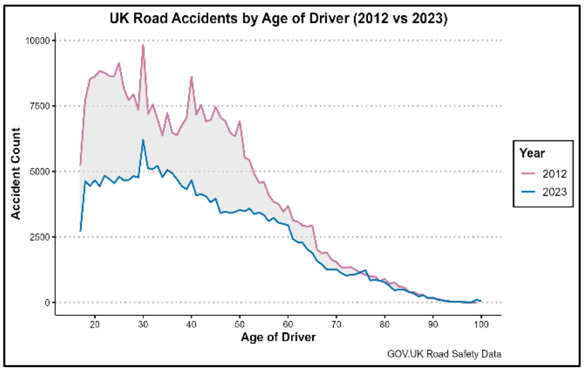
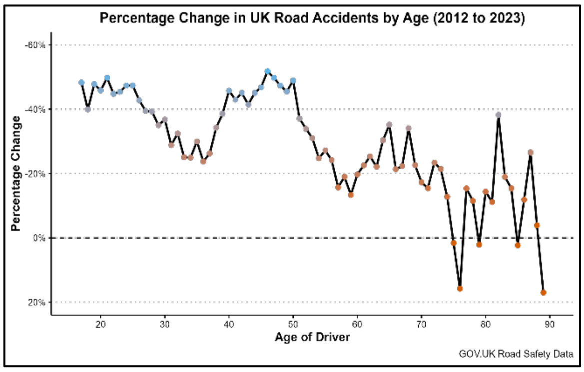


Figure 5



Knowledge Building

According to the World Health Organisation (WHO, 2023), road accidents cause around 1.19 million deaths per year, and up to 50 million non-fatal injuries globally, making them the leading cause of death from injury (WHO, 2024). In the UK, over 29,000 people are killed or seriously injured annually (Department for Transport, 2023), so improving road safety in the UK is essential. Since 2012, there have been a number of regulations related to road safety which have come into effect. For example, in 2012 the UK Government introduced plans to toughen drug-driving legislation (Department for Transport, 2013) and the European New Car Assessment Programme (Euro NCAP) made Electronic Stability Control (ESC) compulsory for all new cars to enhance safety (AA, 2019). Recent technological advances have also encouraged the progression of Advanced Driver Assistance Systems (ADAS) such as lane support systems and emergency brake assistance, representing significant road safety improvements (European Road Safety Observatory, 2018). This composite visualisation provides insight into the impacts that such safety improvements have had. Specifically, it aims to address a question that has been largely ignored in road safety analyses: is the decline in UK road accidents since 2012 consistent across geography, severity, and demographics?

Figure 1 demonstrates that road accidents have reduced across the UK from 2012 to 2023. There is a visible reduction in the density of road accidents in almost every area. There are, however, some areas in which road accident reduction is not clear. These areas correspond with the hotspots identified by Feng et al. (2020) including central London, Manchester and Birmingham. In these highly urbanised areas, accident density is so high that the visualisation loses granularity and differences are not discernible.

Figure 2 shows that, whilst slight accidents have experienced a decline, fatal or serious accidents have risen almost 10%. The trend in slight accident reduction has been identified by the Department for Transport (Department for Transport, 2023); whilst they acknowledge that accidents of slight severity are consistently under-reported in the UK, it is believed that this reduction is an accurate representation of real trends. The rise in the severe category since 2012 is reported by the Department for Transport, but they warn that changes in the ways injuries are reported since 2013 may have skewed some of the severity data. However, they also report adjusted figures which still demonstrate a slight increase in total serious injuries from 2012 to 2023.

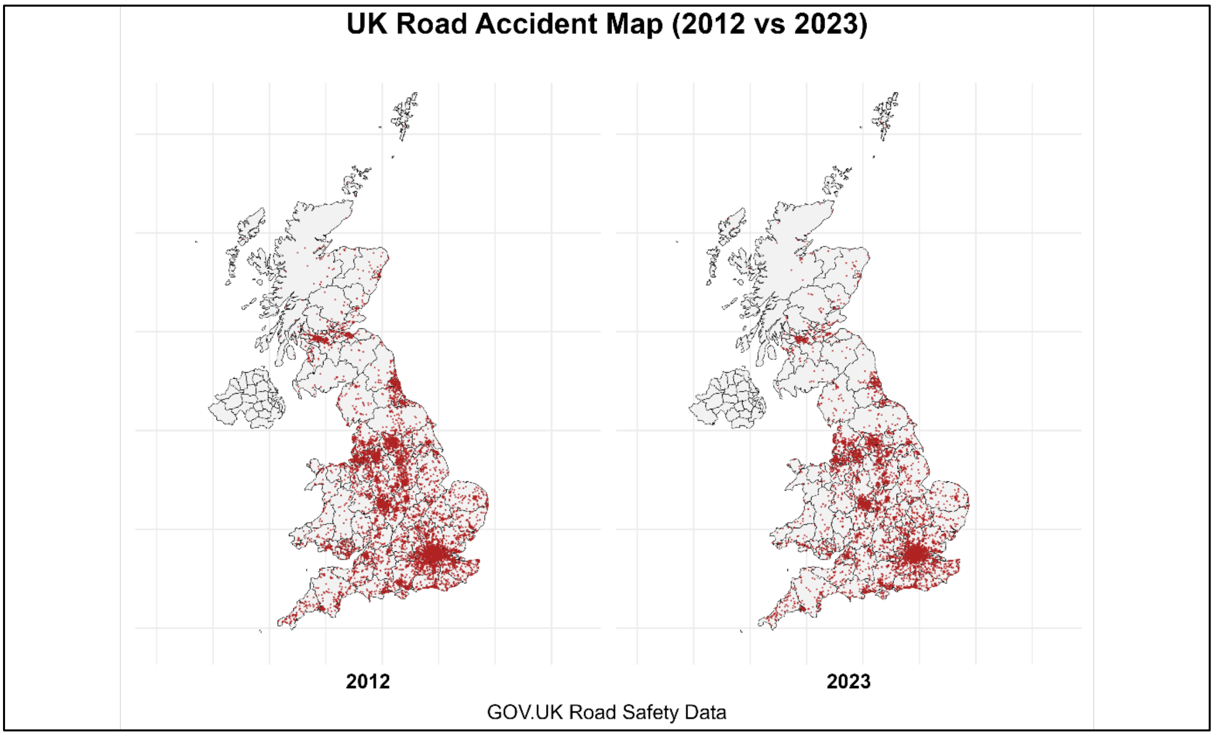
Figure 3 illustrates the percentage reduction in road accidents for each year, compared with 2012. It shows both the total trend, and the sex differences in this trend. The female category has a consistently greater percentage reduction than the male category which suggests that, despite female drivers already making up the minority of car accidents, they have also experienced a greater reduction in car accidents since 2012 than male drivers. From this chart, the impacts of the COVID-19 pandemic can also be inferred. There were sharp drops in road accidents in 2020, consistent with the findings from Yasin et al. (2021) who observed global reductions in traffic accidents, despite increases in extreme cases of speeding. This drop was followed by rises in 2021 and 2022 as the public returned to regular travel (Office for National Statistics, 2024). Without this chart, one might reasonably assume that any reduction in road accidents from 2012 to 2023 was driven by the impact of COVID-19 and the rise in remote working. However, the chart clearly shows a consistent decline beginning before 2020, with the trend resuming in 2023, suggesting a broader, long-term reduction that has occurred independent of the pandemic.

Figure 4 shows the number of road accidents by age in 2012 and 2023. This chart demonstrates that younger people are more likely to be involved in road accidents than older people. However, this pattern is more strongly evident for 2012 than for 2023. Between 2012 and 2023, there is a large decrease in road accidents between the ages 20-55, but this decrease becomes less evident above the age of 55. This suggests that older drivers have experienced a less significant reduction in road accidents than younger drivers since 2012. This idea is supported by other studies that suggest the contributing factors in road accidents involving older people are different from those involving younger people. For example, underlying health conditions and associated medications are more likely to be a factor in accidents involving older people (RoSPA, 2021). These factors are typically complex, individualised and hard to control with car safety features. As such, the progression of safety features since 2012 is unlikely to have had a significant impact on these types of accidents.

Figure 5 builds on the information provided in Figure 4 by explicitly demonstrating how the reduction in road accidents varies with age. Specifically, it shows that ages 55 and below experienced a reduction in road accidents of at least 20%, whereas above the age of 55 the percentage change is lower on average and shows increases for some age groups. This chart also highlights the inconsistency in accident reduction. The percentage reduction varies wildly whereby ages 30-40 experienced reductions of ~25%, whilst ages 40-50 experience reductions of ~50%. Overall, the composite visualization shows that there has been a reduction in road accidents since 2012, but the exact trend varies across geography, severity, sex and age.

Theoretical Frameworks

Figure 1



The ASSERT framework (Ferster & Shneiderman, 2023) was developed to assist with the creation of visualisations that promote accessibility, insight and understanding. The first element of the framework is “Ask a question”, and this informs every subsequent element of the framework. The dot map shown in Figure 1 aimed to address the distribution and prevalence of accidents over time to find out how consistent the reduction of road accidents is across the UK, so that the audience can appreciate the scale of accident reduction that has occurred. Therefore, it was assumed that the audience had a basic understanding of the geography of the UK, but no background knowledge regarding road accident statistics.

The next part of the ASSERT framework is “Search for information” which involves identifying a suitable data source. Few (2009) proposed a series of characteristics that help to make data meaningful. For UK road accidents, the most comprehensive and detailed database is available on the GOV.UK publicly-available datasets, and these datasets adhere to all characteristics proposed by Few. For example, there is a high volume of data because the data contains information of every recorded road accident since 1979. Furthermore, the data is multivariate as it covers dozens of variables relating to each accident such as geographic coordinates, accident severity, sex of driver etc. These qualities made the GOV.UK Road Accident Statistics datasets ideal for answering the given question. The specific datasets used were named “Road Safety Data – Casualties 1979 – Latest Published Year”, “Road Safety Data – Vehicles 1979 – Latest Published Year”, and “Road Safety Data – Collisions 1979 – Latest Published Year”, and can be found at: https://www.data.gov.uk/dataset/cb7ae6f0-4be6-4935-9277-47e5ce24a11f/road-safety-data

The third part of the ASSERT framework is “Structure the data” which requires the organisation of the raw data to prepare for analysis. Three datasets were downloaded from GOV.UK and imported into RStudio. To collate a single dataframe with all necessary data, the three datasets were joined by accident index and then variables were filtered appropriately. Many of the variables were encoded as numbers. By looking at the STATS-19 form which is used for data collection, these variables could be recoded as their true labels.

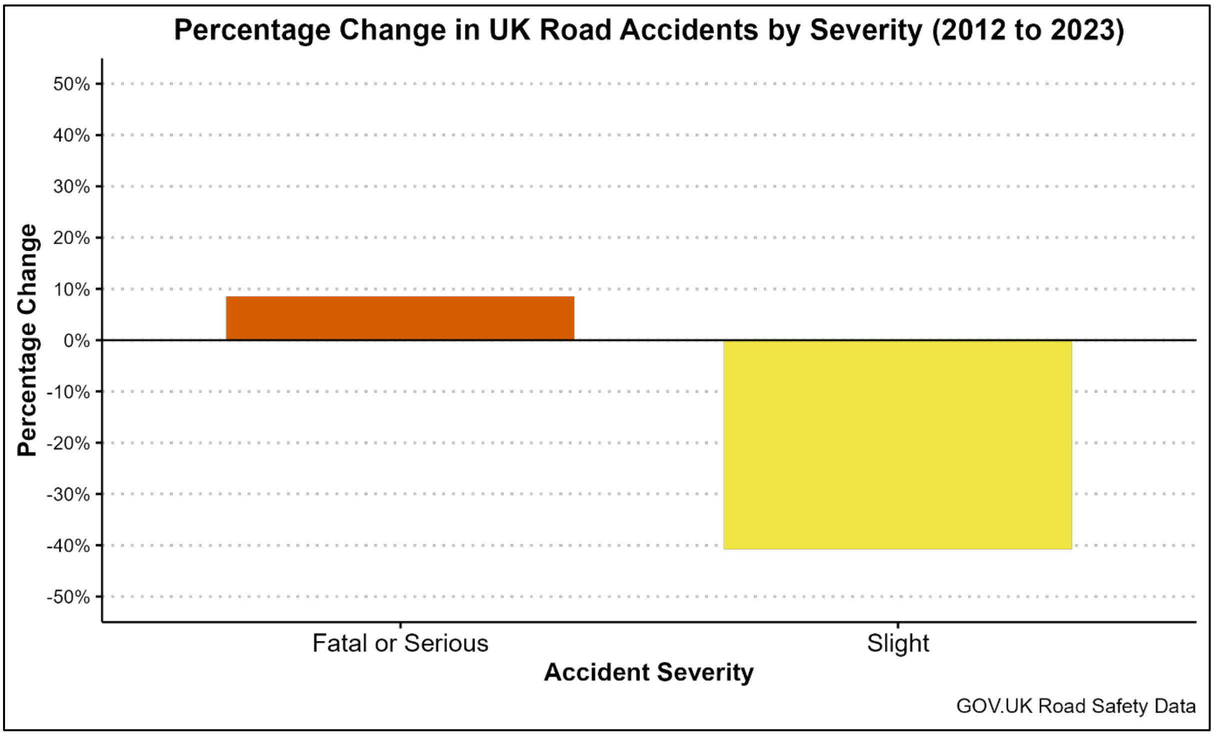
The fourth part of the ASSERT framework, “Envision the answer”, is an exploratory process in which different visualisations are produced and improved iteratively to assess their ability to answer the question. For the present chart, the points were first plotted using the existing coordinates on the dataset, this produced a chart with the distribution of accident locations but with no map for reference. It was clear from this representation that there was a visible reduction in accidents from 2012 to 2023, so this format was developed and improved further.

The fifth part of the ASSERT framework is “Represent the visualization” which ensures that the final visualization contains relevant elements to maximise its accessibility and clarity. The present visualisation was created using various elements of the Grammar of Graphics (GoG; Wilkinson, 2010). In terms of coordinates, the data is overlayed on a map of the UK and the rnaturalearth package was used to plot the coordinates in CRS format. This allowed for additional geographical detail including county boundaries, for which the fill was set to a very light grey to preserve the visibility of dots. Some transparency in the dots was key to ensure that densely populated areas contrasted with less dense areas, so alpha was set to 0.7. Dot sizes adhered to suggestions in the literature; Kirk (2019) emphasises that dots should be “small enough to preserve their individuality but not too tiny as to be indecipherable”, so a dot size of 0.1 was chosen. Since there was only one variable shown on the map, it was only necessary to consider one appropriate colour for the dots. A shade of red named “firebrick” was used because it was sufficiently bright and visible. Furthermore, using red dots to represent accidents is intuitive due to the connotations of danger and severity associated with the colour (Elliot et al., 2015).

The final part of the ASSERT framework is “Tell a story”. This chart aimed to tell the story of how road accident distribution and prevalence has changed from 2012 to 2023. To demonstrate the change that occurred over this time, two charts were positioned adjacent to one another, one representing 2012 and the other representing 2023. By positioning the charts in this way, the visualisation shows a clear contrast between these timepoints, thus telling a story of change over time.

Accessibility

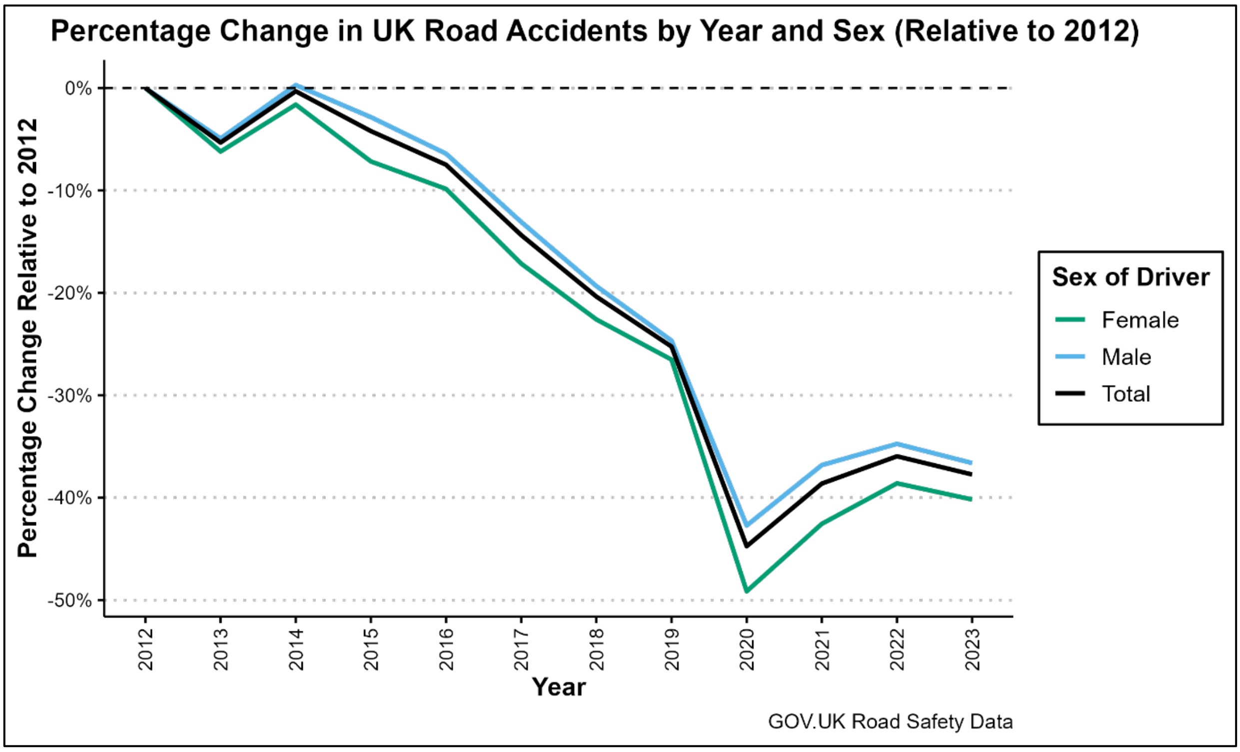
Figure 2



Accessibility in visualisation is the process of ensuring that charts are inclusive so the information they provide can be understood by a wide range of individuals. There are many accessibility guidelines available to scientists creating visualisations. For example, the Web Content Accessibility guidelines (W3C, 2023) suggest that accessible visualisations should be perceivable, operable, and understandable. One way to make visualisations more perceivable is by using colours which can be distinguished by colourblind individuals. Okabe and Ito (2008) developed a colour palette called the colourblind barrier-free colour palette, containing eight colours which can be sufficiently distinguished by colourblind people and are therefore suitable for use in accessible charts and figures. The present chart utilised two colours from the Okabe-Ito palette. Vermillion was used for the fatal or serious category whilst yellow was used for the slight category. The specific shades of these colours in the palette correspond to hexadecimal colour codes #D55E00 and #F0E442 respectively. Within the identified colour palette, these specific colours were chosen because they represent an intuitive contrast whereby audiences associate red with higher levels of danger and severity than yellow (e.g., Elliot et al., 2015), which is suitable for a chart contrasting two different severity levels. It is worth acknowledging, however, that colourblind-friendly palettes are not completely effective. Some colourblind individuals are more severely affected than others (Cole, 2008), so it is unclear whether this palette is suitable for all people. The minimal theme was used on this plot so that dotted y-axis lines were present, allowing the audience to easily see the percentage change represented by each bar. A very light grey is used for this feature by default, but it is worth considering that the low contrast between this grey and the white background may be difficult for individuals with low contrast sensitivity. A darker shade should be considered for similar charts, but this may risk cluttering the chart and distracting the audience from the broader message of the visualisation. It is worth noting that vision is not the only method of perception that should be considered in accessibility. For blind people it is important that there are alternative ways to perceive the information communicated by charts, which is where the present chart may be improved. Audio description of the chart should be considered; whilst not all file types support audio delivery, it should be included wherever possible. The use of braille should also be considered in printed versions of the chart, to provide detailed descriptions to blind people. In terms of operability, this chart is easily accessible through a range of different devices as this file type is widely supported. However, the present file type does not support interactivity, which somewhat limits its operability. The expansion of this chart into an interactive format should be considered as this may encourage a deeper engagement with the topic and more extensive understanding of the trends (e.g., McElhaney, 2015). The final principal of the WCAG is making the chart understandable. The use of concise and clear titles and axis labels means the present chart includes all necessary information to understand the message. It is important that charts do not include excessive text so as to remain accessible to those with conditions such as Dyslexia and Autism Spectrum Disorder (Shin, 2024), but contain enough text for the message to be understood by the audience.

Visualisation Choice

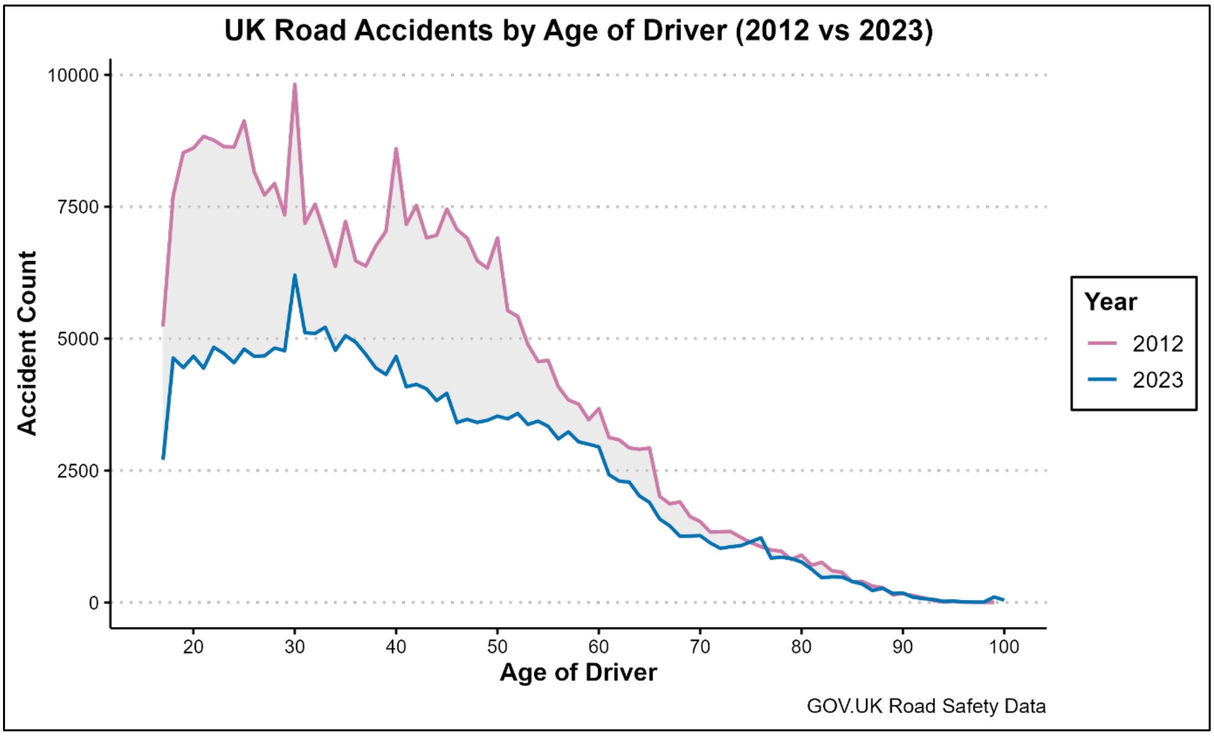
Figure 3



The aim of this index chart was to portray the percentage change in accident prevalence over time. Index charts are a type of line chart that focus on percentage change and are used when raw values are less important than relative changes (Heer et al., 2010). For this reason, index charts are an ideal way to visualise the percentage change in the number of accidents over time. The ability to plot multiple channels on the same plot in an index chart makes it particularly informative. For example, in the present plot, accidents clearly reduced in all groups from 2014 to 2020, followed by an increase from 2020 to 2022, demonstrating the impact of the pandemic. It is also clear that the female group consistently had a greater percentage reduction than the total or male groups. A limitation of index charts, however, is that it can be difficult to identify discrete values for individual time points. For example, in this chart it is not clear what the percentage change was in 2017 or what value this corresponds to. An alternative method of visualisation for this chart is a bar chart. Bar charts represent quantitative values across categories or time, with the height or length of each bar corresponding to its relevant value. A chart could be created with bars for each year extending from the line y = 0, representing the percentage change or accident count. To incorporate multiple groups for male, female and total, a stacked bar chart may be used which stacks the bars for each sex, creating a larger bar that represents the total. Alternatively, a clustered bar chart would position the subcategories adjacently within the same year, so they could be analysed individually. However, a limitation of these methods is that they can quickly become cluttered if there are many time points and categories. Furthermore, bar charts tend to emphasise the discrete values of each category or time point as opposed to overall trends. For these reasons, these methods may not be effective at portraying the intended message, which is where the index chart is particularly impactful. Another alternative to the line chart for this topic is the stacked area chart. This represents how quantitative variables have changed over time for different categories, whereby each category is a line stacked upon the previous category, with the difference shaded for clarity. In the present example, this may include a shaded area representing the number of accidents in the female category for each year, with another shaded area stacked on top to represent the male category. The change in the sizes and proportions of the areas across time would represent how these categories had changed, so the audience could observe the overall trend. The limitation with stacked area charts is that it can be difficult to compare the trends across different categories. For example, females are involved in fewer road accidents than males (GOV.UK, 2024), so a percentage change the female category may appear less significant than the same percentage change in the male category. This may mislead the audience and portray the wrong message. The benefit of using the present index chart is that the categories can be directly compared in a more informative way.

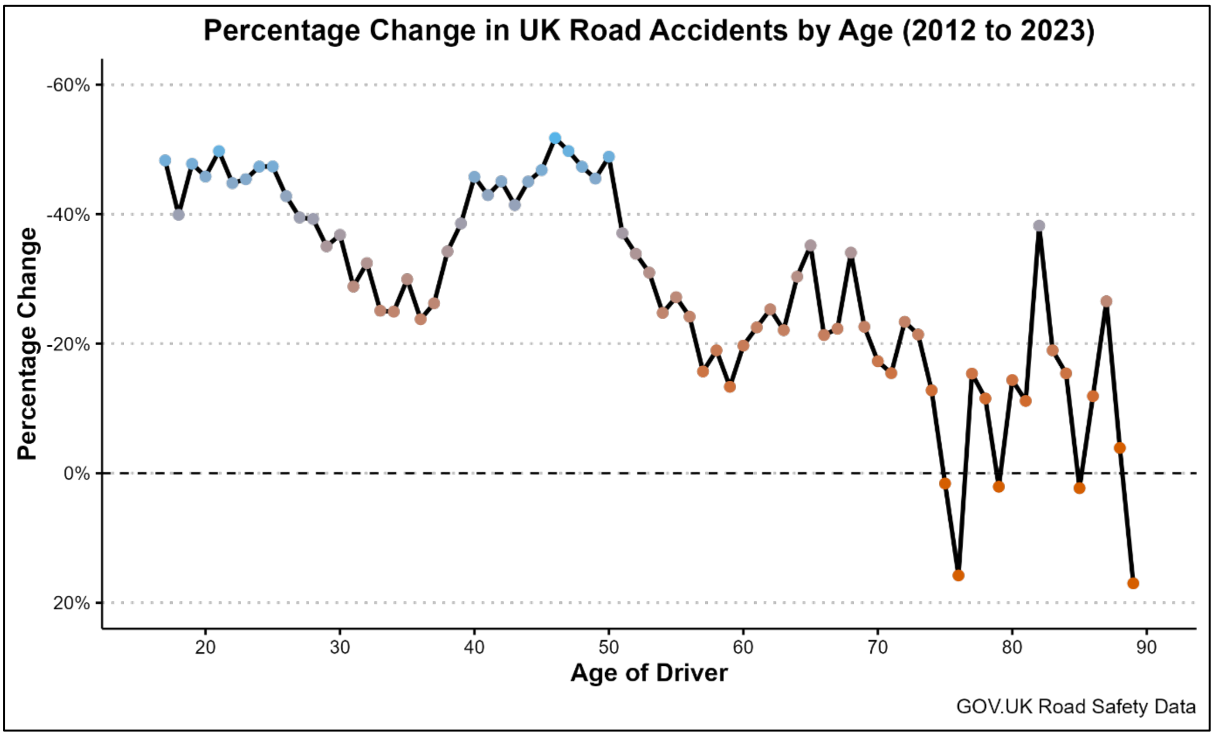
Implications and Improvements

Figure 4



This line chart shows the prevalence of road accidents across different ages in 2012 and 2023. The chart demonstrates that, whilst younger drivers are generally more likely to be involved in road accidents, there has been a significant reduction since 2012. One ethical consideration to make when it comes to this chart is that there is a lack of connection between the audience and the reality of what the chart represents. Whilst this chart may represent accurate statistics, it is a wholly unemotional experience for the audience which is far removed from the reality of road accidents. Correll (2019) proposed the idea of anthropomorphizing data so that audiences feel a connection to the people represented in the visualization, in a way that more accurately reflects reality. In this way, there are several improvements that could be made to this chart such as adding human-centric data such as quotations or pictures or incorporating a title or caption that engages the audience more directly. Another ethical consideration is how the media could abuse this information by focusing on the negative aspects. One attribute that may be taken from this chart is simply that young drivers are more likely to be involved in accidents and are therefore dangerous drivers, which entirely omits the positive trends that have taken place. Narratives like these are extremely common. For example, in a press release by IAM RoadSmart the Director of Policy and Standards claimed that “something is going awry with driving standards among younger drivers” (Dundon et al., 2024). And this was echoed in media articles (e.g., Lancefield, 2024). Whilst these claims are not untrue according to DVLA statistics, they are a major oversimplification as the data they refer to focused solely on dangerous driving for which there had been changes in law enforcement practices (Morris, 2022). Media outlets tend not to compliment their claims with the positive progress that has been made in reducing the number of accidents involving young drivers. There are major ethical risks posed by unbalanced media, both in misleading the public and in the promotion of self-fulfilling prophesies which may cost lives. The self-fulfilling prophesy (Merton, 1948) is a psychological term describing the tendency for individuals to internalise societal expectations and adhere to them. For example, if an individual believes that society perceives them as criminal or deviant, then they are more likely to commit crime (e.g., Esmaeilpour, 2021). In the same way, there is a risk that the demonisation of young drivers is itself a risk factor for worsening driving standards through the self-fulfilling prophecy (Watt et al., 2012). As stated by Yogalingam (2023), “there is a need to shift the conversation away from victim blaming youth and labelling them as the cause of unsafe roads and toward facilitating youth empowerment”. To prevent the weaponisation of this chart by the media, it may be possible to reframe the information in a more positive way that emphasises the positive progress that has been made. Figure 5 is an index chart which displays the percentage change in road accidents by age and emphasises the improvements that have been made in almost all age groups. Whilst this doesn’t allow for detailed comparison of accident prevalence across ages, the message of accident reduction is a powerful one which would not be as easily misunderstood or abused.

Figure 5


Percentage Change in UK Road Accidents by Age (2012 to 2023)
-60%
-40%
-20%
0%
20%
Percentage Change
20
30
40
50
60
70
80
90
Age of Driver
GOV.UK Road Safety Data

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